EUROPEAN FOREST INSTITUTE

(The atlas of)

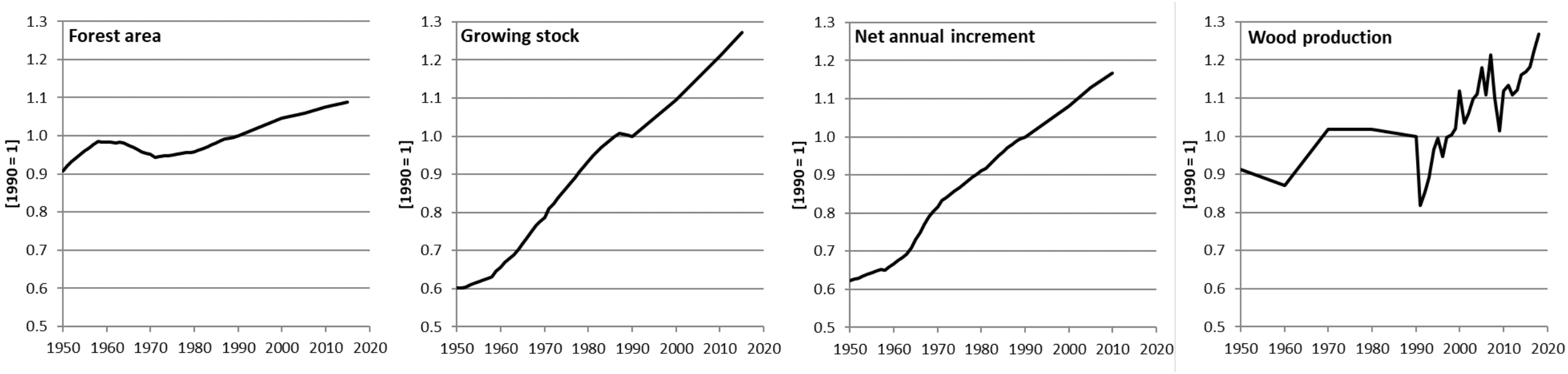
Forest management practices in Europe

Hans Verkerk & Marcus Lindner

Managing forests in the 21st century, 3-5 March 2020, Potsdam

European forests

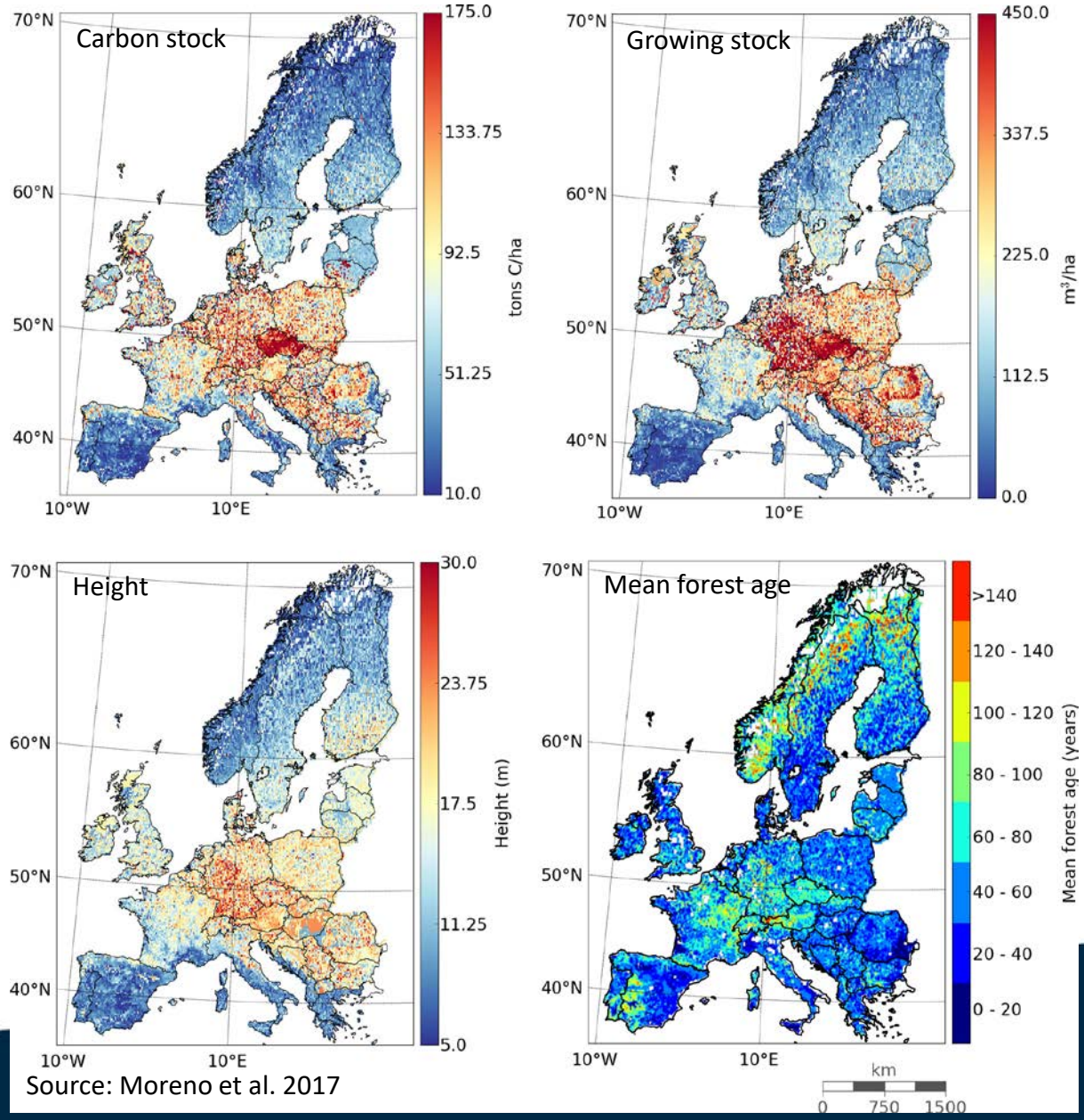
- Large changes in European forest resources during recent decades



Source: adapted from Verkerk 2015; multiple data sources

European forests

Source: Sabatini et al. 2018



Source: Moreno et al. 2017

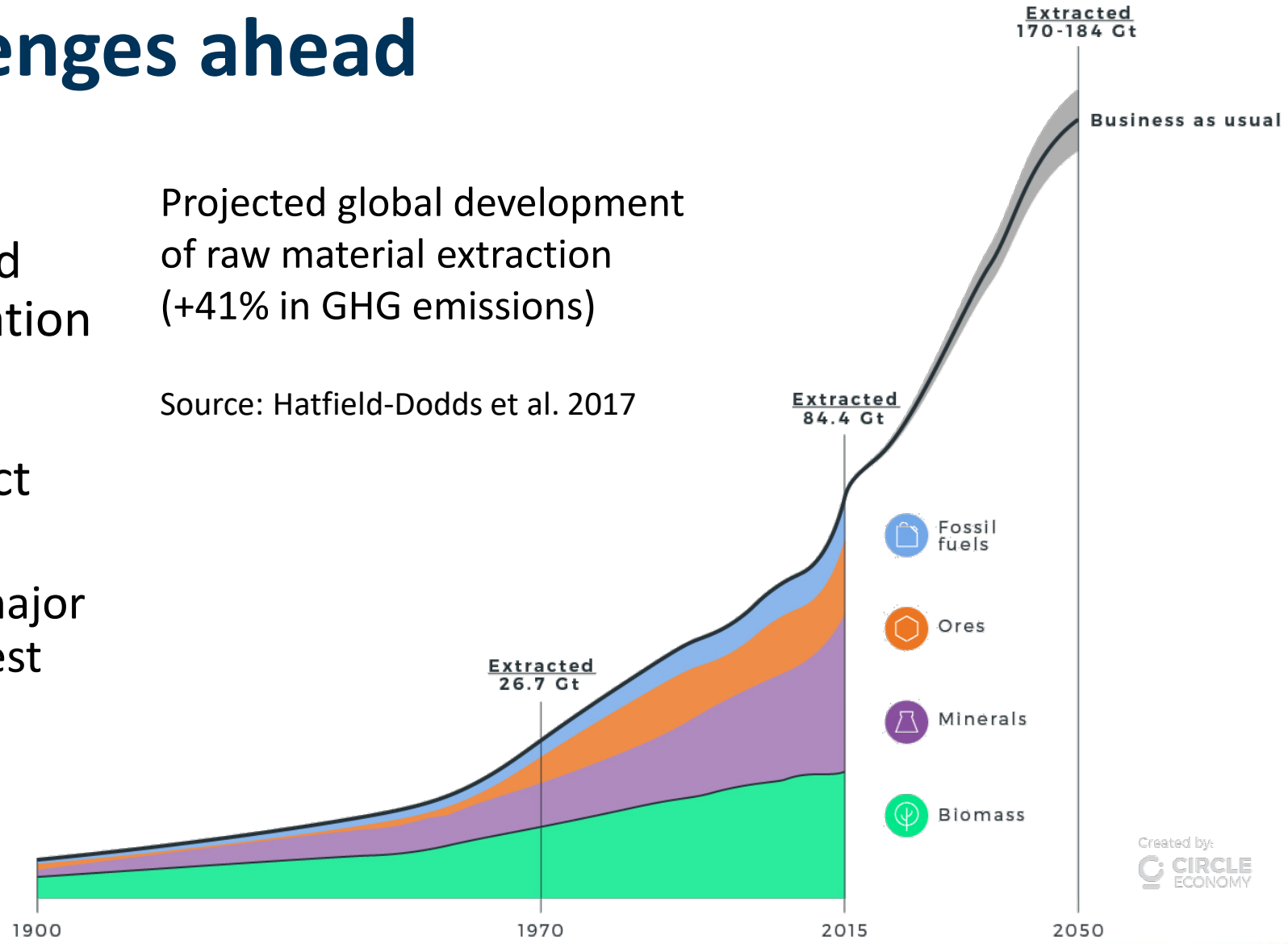
Management challenges ahead

- Increasing global demand for materials due to a growing and increasingly rich global population

- How will future demands affect European forests?
  - Latest outlooks suggest no major changes in roundwood harvest and consumption until 2030 (Jonsson et al. 2018)

Projected global development of raw material extraction (+41% in GHG emissions)

Source: Hatfield-Dodds et al. 2017



Management challenges ahead

- Climate change and large disturbances projected to affect Europe's forests

Forest management in Europe

- Improved information is needed on how forests are currently managed in Europe
  - Development of overview of forest management in Europe in GenTree project

- Overview per forest management decision
  - Forest management approach fra[illegible]t by Duncker et al. [illegible]ext s[illegible]e)
  - Main source of i[illegible]f[illegible]ation: literatur[illegible] ta[illegible]ie[illegible] yearbook[illegible] da[illegible]bases

- Co[illegible]ry [illegible]eve[illegible] [illegible]ervi[illegible]w [illegible] e[illegible] fo[illegible]st manage[illegible]oice
  - [illegible]te[illegible]s: quali[illegible]e descriptions [illegible] management practices in a country
  - [illegible] countries, inv[illegible] experts (external to the project!)

- Focus on EU for period >1990

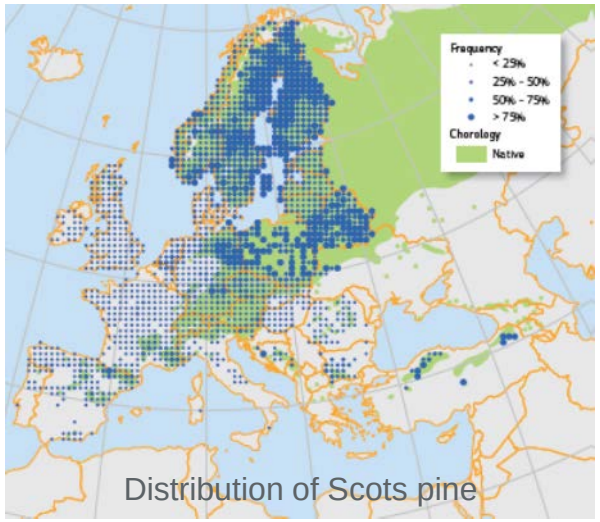
SPOILER ALERT

Forest management decisions

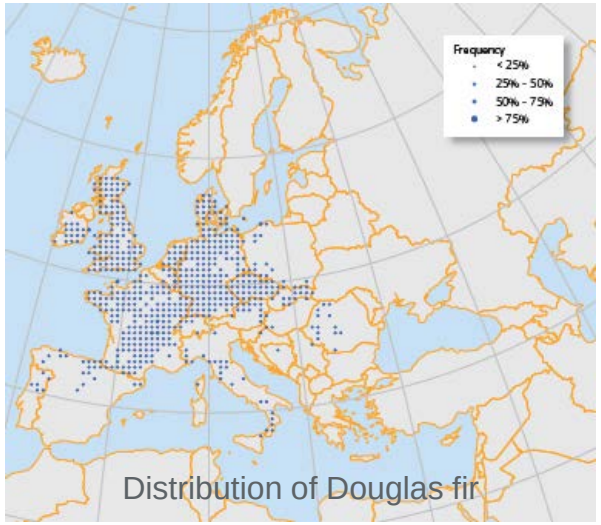
Source: Duncker et al. 2011

Decision	Silvicultural operations	Considerations
Naturalness of tree species composition	Selection of tree species	Species composition in relation to the potential natural vegetation, share of site-adapted tree species, share of introduced tree species
Type of regeneration	Stand establishment	Planting, seeding, natural regeneration, or coppice
Forest reproductive material	Selection of tree genotypes	Use of improved breeding material, use of genetically modified organisms
Machine operation	Fertilizing, Liming, Soil preparation, Thinning, Final harvest	Use of forest machinery for soil preparation, thinning, final harvest
Soil cultivation	Soil preparation, Drainage	Mechanical, physical, and chemical site preparation, drainage
Fertilization / Liming	Fertilization, Liming	Fertilization to increase yield (amelioration), compensation for nutrient extraction and re-establishment of natural biogeochemical cycles
Application of chemical agents	Pest control	Application of pesticides, herbicides
Integration of nature protection	Tree retention, special habitats	Tolerance of biotope/habitat trees, tolerance of deadwood, biotope protection within stands
Final harvest system	Final harvest	No management, continuous cover, even-aged forest with shelterwood, even-aged forest with clearcutting, coppice, coppice with standards, short rotation
Maturity	Final harvest	Felling age in relation to the potential life span of a given tree species
Wood removals	Thinning (stem), Final harvest (stem), residue removal, stump removal	Tree components (stem, residues, stumps) extracted in thinning or harvesting operations

Naturalness of tree species composition



Distribution of Scots pine

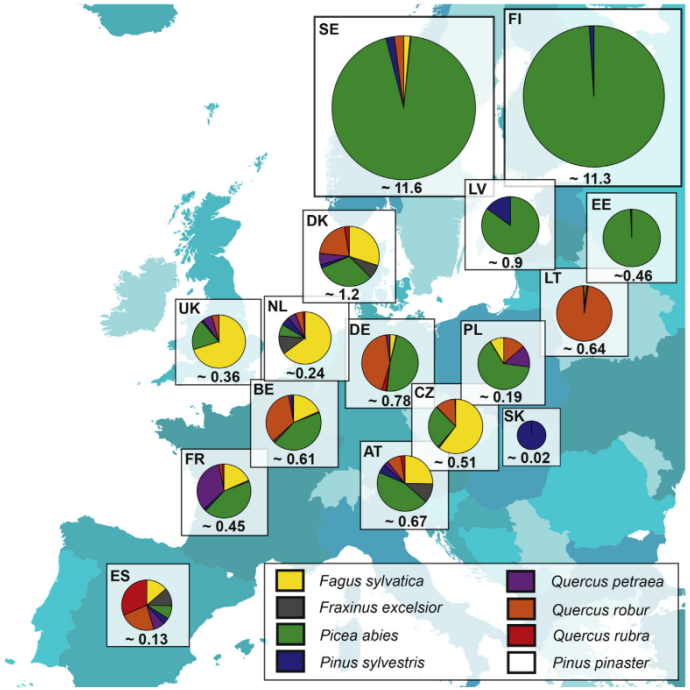


Distribution of Douglas fir

Source: San-Miguel et al. 2016

- The naturalness of the tree species composition in relation to the potential natural vegetation of a site.
- Good information availability from multiple sources on species composition, limited information on changes in tree species composition
- Decrease in forest area dominated by a single tree species and increased preference for broadleaved species (mainly central Europe)
- The area covered by non-native species has increased steadily in most parts of Europe between 1990 and 2015

Forest reproductive material

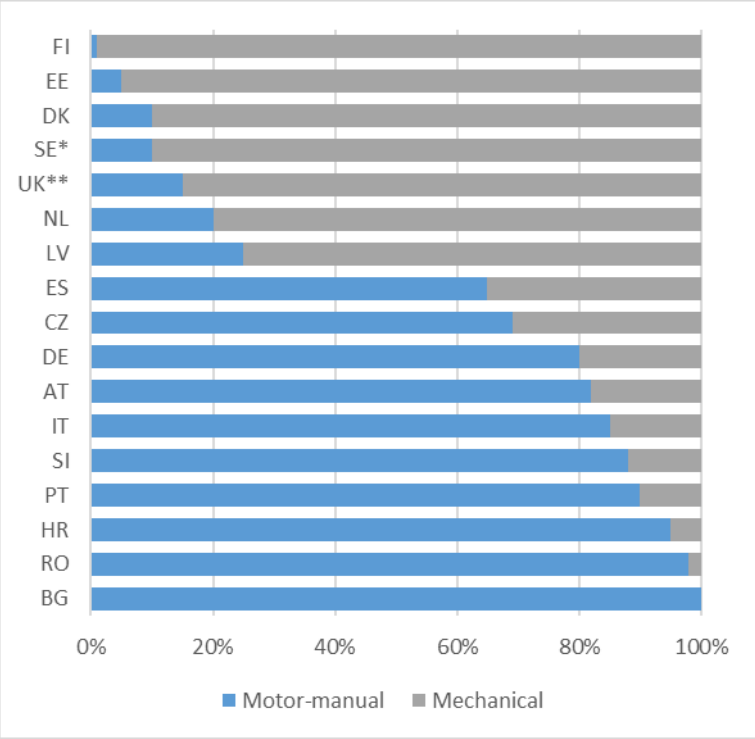


Annual plant transfer (in million) by country and species based on the period 2004 until 2014. Size of pie charts corresponds to the quantity of introduced seedlings

Source: Jansen et al. 2019

- Decision by a forest manager on the material to be used during the regeneration stage
- Rather good information on the availability and types of forest reproductive material, limited information on what is used
- Bare root seedlings are most commonly used for planting

Machine operation

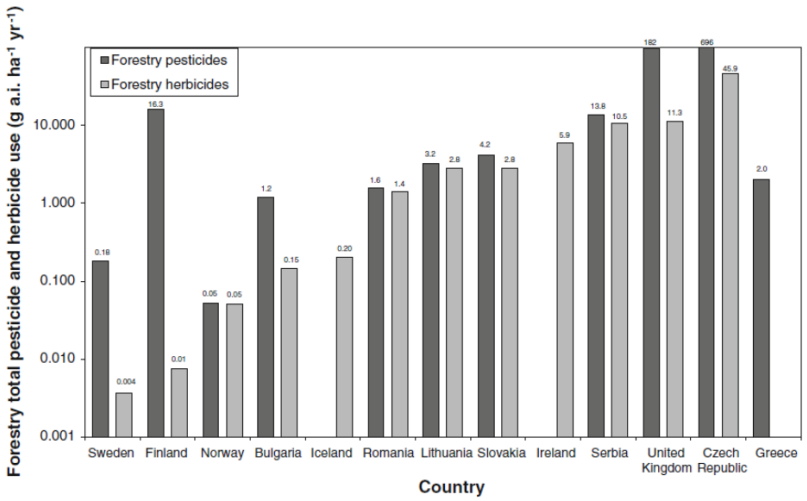


Degree of mechanization in harvesting activities

Source: Prinz and Anttila (unpublished)

- Vehicle movements on the forest soil and the degree a forests needs to be opened up to ensure access of the machinery
- Poor information availability
- Site preparation: mainly tractor with plough
- Regeneration: mainly manual (approx. 5% mechanically planted in Finland)
- Harvesting: large differences between countries

Application of chemical agents



Forestry pesticide and herbicide use in 2009 in 13 European countries

Source: McCarthy et al. 2011

- Use of chemical substances to reduce or prevent competition or pests that may negatively affect the establishment and development of a stand
- Poor information availability
- The amount of pesticides used in European forestry is significantly less than the use in agriculture. When applied the amounts per application range between 0.1 and 2.2 kg active ingredient ha^{-1} yr^{-1}
- Mechanical control of unwanted plants more common than use of herbicides

Cutting regimes

Management system	Species group	North	Central -West	Central -East	South-West	South-East
Even-aged forest: Uniform clear-cut system	Light demanding conifers					
	Shade tolerant conifers					
	Mediterranean conifers					
	Fast growing deciduous					
	Slow growing light demanding deciduous					
	Slow growing shade tolerant deciduous					
Even-aged forest with shelterwood	Light demanding conifers					
	Shade tolerant conifers					
	Mediterranean conifers					
	Fast growing deciduous					
	Slow growing light demanding deciduous					
	Slow growing shade tolerant deciduous					
	Mediterranean evergreens					
Continuous cover forest management	Shade tolerant conifers					
	Slow growing shade tolerant deciduous					
Coppice	Fast growing deciduous					
	Slow growing light demanding deciduous					
	Mediterranean evergreens					
Coppice with standards	Slow growing light demanding deciduous					
	Slow growing shade tolerant deciduous					
Short rotation	Light demanding conifers					
	Fast growing deciduous					

Common harvest systems in Europe (darker shading indicates a system is more common)
Source: Cardellini et al. 2018 & Härkönen et al. 2019

- The extent that a forest area is cleared - or to which the forest canopy is opened up - by a (final) harvest operation
- Limited information availability
- Clear-cutting is the dominant harvest system in Europe, but there is a trend in adopting other systems to develop more structurally rich forests (central Europe and the British Isles). Clear-cutting has been forbidden in Slovenia since 1947
- 8.8-20 million ha of coppice forests; most coppice forests are to large extent abandoned

Country narratives

AUSTRIA

Rupert Seidl

Technical University of Munich, Germany

Naturalness of tree species composition

As the result of past management, the current tree species composition differs from the potential natural vegetation in many parts of Austria. In particular, Norway spruce (*Picea abies* (L.) *Karst.*), Scots pine (*Pinus sylvestris* L.) and European larch (*Larix decidua* L.) are overrepresented, while Silver fir (*Abies alba Mill.*) and broadleaved species (particularly European beech, *Fagus sylvatica* L.) are currently underrepresented (Figures 1 and 2). However, Austria's forests are characterized by great heterogeneity in climate and site conditions, ranging from broadleaved-dominated natural forest types in the low elevation areas to conifer-dominated natural forest types in high elevation areas. Generally, the naturalness of the current vegetation composition increases and the human influence on forests decreases with elevation.

In the current silvicultural planning and tree species selection, potential natural vegetation is widely used as a guideline in Austrian forestry. Consequently, the share of Norway spruce has decreased and the share of broadleaved species has increased since the 1990s (Figure 3). Climate change adaptation is increasingly discussed in the context of tree species selection, and subsidy programs often promote establishing mixed and/or broadleaved-dominated forest types in anticipation of future warming.

The share of non-native tree species remains very low, approximately 0.5% of the growing stock, and is restricted to specific sites, e.g. floodplain forests along the Danube, dry low elevation

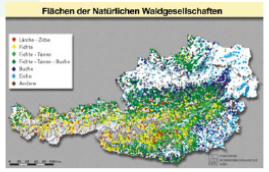


Figure 1. Map of natural forest types in Austria.
Lärche= European Larch, Zirbe= Swiss stone pine,
Fichte = Norway spruce, Tanne= Silver fir,
Buche= European beech, Eiche= Oak, Andere= others.
Source: Federal Research and Training Centre for Forests, Natural Hazards and Landscape (BFW).

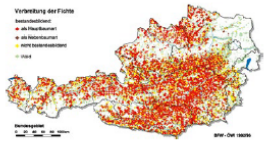


Figure 2. Current distribution of Norway spruce in Austria.
Red: main tree species, brown: co-dominant tree species,
yellow: present but not a main canopy species.
Source: Federal Research and Training Centre for Forests, Natural Hazards and Landscape (BFW).

BELGIUM

Ilié Storms and Bart Muys

KU Leuven

Introduction

Belgium has a fairly stable forest area of about 700 000 ha, of which 550 000 ha is in Wallonia, 150 000 ha in Flanders and a small share (2240 ha) is located in Brussels (Figure 1) [1; 2]. In the southern, less populated upland region of Wallonia, forestry is a major economic activity, while in the northern densely populated lowland region of Flanders, forests offer mainly amenity and conservation services. Forest policies in both areas are different, with separate legislation and separate forest administration. About half of the forests in Belgium are PEFC (43%) or FSC (4%) certified. PEFC certification is most prominent in the Walloon region, while FSC certification is dominant in Flanders [3].

A distinctive feature of Belgian forests is the high degree of fragmentation, both geographically and in ownership. Forest management is therefore difficult to organize, as owners all have their own preferences, managing forests with productive, recreational or environmental goals in mind, or not managing at all. Public forests and private forests in group management are often managed in a multifunctional manner, which leads to increasing mixtures and more diverse vertical structures.

Naturalness of tree species composition

The current species composition is Belgium is largely different from the potential natural vegetation. More than half of the forest area consists of forests established in the last 150 years on degraded grazing land or marginal agricultural land, mainly with fast-growing species like pines and spruces. Another important part are ancient forests, often traditionally and sometimes still, managed as coppice or coppice with standards, with dominance of oak. The potential natural vegetation, which is often beech forest, oak-hornbeam or oak-birch forest depending on climate and soil, is only present in less than 25% of the forest area, but is increasing, due to natural succession or less intensive management. While conifers were the dominating species after World War II, the broadleaved cover

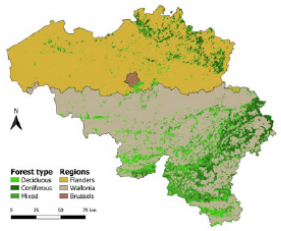


Figure 1. Forest distribution in the three major regions of Belgium – Flanders, Wallonia and Brussels – showing deciduous, coniferous and mixes stands [4].

CROATIA

Krunoslav Indir[1], Goran Kovač [2] and Hrvoje Marjanović[1]

[1]Croatian Forest Research Institute [2]Croatian Forests Ltd

Naturalness of tree species composition

The total forest and other wooded land area in Croatia is 2 536 650 ha (2016), which is 45% of the total land area. Forests are found in three biogeographical regions: Continental (about 44% of forest and other wooded land area), Mediterranean (39%) and Alpine (23%).

Domestic tree species dominate with 96.7%, site-adapted allochthone species (*Robinia pseudoacacia*) form 2.3% of the forest area, and other introduced species 1.0% (Table 1). Since 1990, plantation areas have been decreasing and replaced with stands composed of tree species that would occur naturally in close-to-nature managed areas. Also, the share of stands with dominant introduced tree species is decreasing.

The ten most common tree species are common beech (37% of total growing stock), pedunculate oak (12%), sessile oak (9%), common hornbeam (8%), European silver fir (8%), narrow-leafed ash (3%), Norway spruce (2%), black alder (2%), Turkey oak (2%) and black locust (2%). Except for black locust, which is an introduced and site-adapted species, all of the above are native species. The shares of tree species have been affected by management, for example, forest management in the mountain region of Croatia during the late 1800s promoted naturally occurring silver fir at the expense of common beech at sites where both species were present. The close-to-nature management system, in particular since 1990, has promoted species composition which reflects the natural species composition, except in forest plantations.

Year	Forest area (FRA definition)	Plantations			
		All tree species		Introduced tree species	
	1000 ha	1000 ha	%	1000 ha	%
2020*	1939	69	3.5	19	1.0
2015	1922	75	3.9	22	1.1
2010	1920	75	3.9	25	1.3
2005	1903	76	4.0	27	1.4
2000	1885	82	4.3	27	1.4
1990	1850	92	5.0	28	1.5

*projection

Table 1. Share of plantations. Sources: Hrvatske šume Ltd. [1, 2; 3, 4] and data provided by authors.

Type of regeneration

Natural regeneration is the most common form of regeneration and it is carried out mainly in high forests with native species of trees (pedunculate oak, narrow-leafed ash, sessile oak, European beech). In even-aged forests this means two to three cuts (shelterwood cutting). Regeneration can take place through natural seed dispersal or by sowing of seeds of the same tree species in years of weaker seed yield. In the high stands of black alder, poplars and willows, clearcutting and

CYPRUS

Georgios Georgiou

Department of Forests, Cyprus

Naturalness of tree species composition

The forests in Cyprus are mostly natural coniferous forests, mainly covered by *Pinus brutia* and to a lesser extent by *Pinus nigra* and *Cedrus brevifolia*. *Pinus brutia* is the main forest species, appearing in pure or mixed stands, and it covers more than 90% of the total forest area of the island. Broadleaved forests cover only 1130 hectares (<1% of total forest area) and include riparian high vegetation of *Platanus orientalis* and *Alnus orientalis*. Extensive areas are covered with natural woody shrub vegetation (other wooded land)

Exotic species, including *Acacia spp* and *Eucalyptus spp.*, were introduced from the late 18th century until 1990. *Eucalyptus spp* cover an area of 400 hectares while *Acacia spp* grows mixed with other species.

Table 1 shows that 18.67% of the total area of Cyprus is covered by high forests.

Type of regeneration

Natural regeneration as a natural process is the main method of reestablishing a forest. Approximately 82% of the forests are naturally regenerated while the rest are artificially reforested with native or alien species. Natural resprouting is used when shrubs or broadleaved tree species are regenerated naturally after a fire. Artificial regeneration takes place mainly after forest fires, most preferably by sowing and in a lesser percentage by planting. Planting and seeding programmes have also been used to treat understocked sites across the island.

Class	Area (ha)	% of the total area of Cyprus
Forests	172 604	18.66
Other Wooded land	213 530	23.08
Total	925 150	100

Table 1. Forest areas in Cyprus according to the total land (1000 ha).

Forest reproductive materials

In Cyprus, the method applied for ex-situ conservation of indigenous species includes the collection and storage of seeds of the main tree species (i.e. *Pinus brutia, Pinus nigra, Cedrus brevifolia*) and other priority species. The seeds are stored in seed banks and are used for planting in forest nurseries and for sowing in areas where artificial regeneration is applied.

Machine operation

Machinery is not extensively used in soil preparation, only mini diggers, hand tools and light bulldozer are used, where necessary. Also light machinery (mini diggers and light bulldozers) is used in final harvesting. Thinning is done motor-manually using chainsaws.

Soon available from www.efi.int

(Climate-) Smart Forestry

- Atlas provides valuable information on how management could be improved to address multiple societal demands, while considering regional conditions in an uncertain future


Photo: Snežana Trifunović

•Conserve high carbon stocks in old forests that are not at a high risk of disturbance;

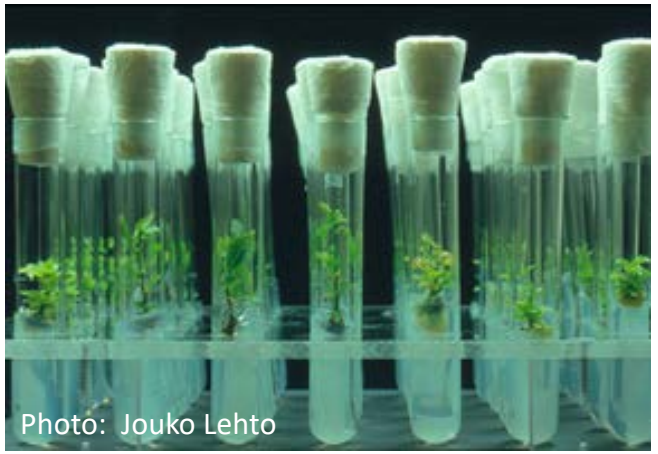


Photo: Jouko Lehto

•Optimize forest genetic resources and silviculte (breeding material, planting, tending and harvesting) in forests that are grown primarily for timber


Photo: Cameron Strandberg

•Activate and improve the management and protection of fire-prone forests to safeguard their carbon stocks;


Photo: Magnifica Comunita di Fiemme

•Increase share of broadleaves and mixed forests to enhance resilience

Concluding remarks

- Information basis on state of Europe's forests is improving, but solid information is needed on forest management:
  - Limited information available for numerous management decisions (e.g. machine operation, fertilization, application of chemical agents, cutting regimes);
- Atlas reveals substantial differences in management between European regions and countries.
- Atlas provides value information for developing:
  - Climate-smart forestry strategies
  - Forest Reference Levels
  - Forest genetic resource conservation and use
  - Outlook and scenario studies
  - ...

PublicDomainPictures; Pixabay

EUROPEAN FOREST INSTITUTE

Thank you!